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SUBMISSION OF SUBSTITUTE SPECIFICATION

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Sir:

Attached are a Substitute Specification and a marked-up copy of the original specification. I certify that said substitute specification contains no new matter and includes the changes indicated in the marked-up copy of the original specification.

Respectfully submitted,

August 17, 2006

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Arrangement for Sensing a Frontal Impact of a Motor Vehicle

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a national stage of PCT International Application No. PCT/EP2005/001492, filed February 15, 2005, which claims priority under 35 U.S.C. § 119 to German Patent Application No. 10 2004 008 005.4, filed February 19, 2004, the entire disclosures of which are herein expressly incorporated by reference.

BACKGROUND AND SUMMARY OF THE INVENTION

[0002] The invention relates to an arrangement for sensing a frontal impact of a motor.

[0003] In modern motor vehicles, numerous active and passive safety devices are used to reduce the consequences of an accident for a vehicle occupant and, if appropriate, another party (e.g., a pedestrian) involved in the accident. To trigger safety devices such as restraint means in the form of seatbelt pretensioners, airbags, etc., or to raise the engine hood to protect a pedestrian, the prior art provides both mechanical and electrical sensors which differentiate a crash situation from normal driving conditions, mainly on the basis of deformation or acceleration.

[0004] The sensors which are installed on the vehicle can be provided in order to actuate preventative measures, which are taken before an accident, and acute measures, which are taken after an accident has been detected. It is possible in this context to differentiate the type of impact, such as a frontal impact or a side impact.

[0005] German patent document DE 2 212 90 discloses a collision sensor for activating a restraint device for vehicle occupants in vehicles in the event of an accident-related deceleration of the vehicle. The collision sensor is embodied as a contact strip made of an elastic material, which is arranged on an external part of the vehicle. At least two contact elements, which lie opposite one another in an at least approximately horizontal plane, are embedded in the elastic material. In the event of an impact of the vehicle, the contact element which lies farther on the outside comes into contact with the other party in the accident and is pressed against the corresponding contact element which lies on the inside. The relative speed of the parties in the accident is calculated from the distance between the two contact elements and the difference in time between the impulse on the first contact element and the impulse on the second contact element. When a predefined value is exceeded, a restraint system is triggered.

[0006] A disadvantage with this known collision sensor is that the other party in the accident must first travel a specific distance in the elastic embedding material in order to come into contact with the first, external contact element, in which case however, both the first and the second contact elements are displaced as a result of displacement of the elastic embedding material.

[0007] The deformation of the contact strip thus does not provide a reliable measured section for measuring time. In addition, the result of the measurement of time is highly temperature-dependent.

[0008] Determination of the difference in speed between the parties in the accident is consequently subject to uncertainties which can have adverse effects on the speed of the triggering of the safety devices.

[0009] An object of the present invention is therefore to provide an arrangement for sensing a frontal impact of a vehicle, which permits safety systems to be triggered quickly and in a way that is appropriate for the situation, when the motor vehicle is involved in an accident.

[0010] This and other objects and advantages are achieved with an arrangement for sensing a front impact according to the invention, in which a plurality of impact sensors are connected to a control device and are integrated into the bumper of a motor vehicle. The impact sensors include first contact sensor elements, which are disposed to the front of the vehicle, and second contact sensor elements, which are disposed away from the front of the vehicle. The contact sensor elements are spaced apart from one another and separated from one another and by a free cavity, which forms a measured section. The arrangement permits more precise acceleration signals or speed signals to be generated at a very early time in the crash sequence, when a vehicle impact occurs at a front part of the front of a motor vehicle or a front part of the rear of a motor vehicle. When force acts on the contact sensor element which is disposed to the front of the vehicle, the contact sensor element which is disposed away from the front of the vehicle is not displaced or the measured section is changed in some other way.

[0011] The invention thus permits the fastest possible triggering of the safety devices in a way which is adapted to the situation and with a high degree of resolution quality. For example, the relative speed with respect to the other party in the collision and an accident severity value which is derived therefrom may be considered.

[0012] In one advantageous embodiment of the invention, in terms of improved protection for pedestrians, it is possible to provide for a cavity which forms the measured section to be surrounded by a foam-like shaped element, thus providing damping when the vehicle impacts against a pedestrian.

[0013] Two exemplary embodiments of an arrangement according to the invention for sensing a frontal impact of a motor vehicle are illustrated in more detail in the drawings and explained in more detail in the following description.

[0014] Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

[0015] Figure 1 is a schematic plan view of a motor vehicle, including a simplified block diagram of an arrangement according to the invention for sensing a frontal impact of the motor vehicle;

[0016] Figure 2 is a schematic cross section of a first embodiment of an arrangement of contact sensor elements of an impact sensor on a bumper according to the invention; and

[0017] Figure 3 is a schematic cross section through a second embodiment variant of an arrangement of contact sensor elements.

DETAILED DESCRIPTION OF THE DRAWINGS

[0018] As is apparent from Figure 1, a motor vehicle 1, which may be a passenger car or a utility vehicle, has a sensor safety system 2 which comprises a control device 3, an impact sensor system 4, a driving situation data detection unit 5 with a vehicle state sensor system 6, a device 7 for detecting the surroundings of the vehicle and a passenger compartment sensor system 8. The safety sensor system 2 of the motor vehicle 1 is applied here in different stages as a function of the danger level or severity of the accident for the motor vehicle 1.

[0019] In the embodiment shown, the impact sensor system 4 comprises a central sensor device 9 which is connected to the control device 3 and which constitutes what is referred to as a crash sensor. The central sensor device 9 determines accelerations both in the x direction and in the y direction (i.e., in the longitudinal direction of the vehicle and the lateral direction of the vehicle), and thus detects a frontal impact or a side impact.

[0020] In addition to the central sensor device 9, decentralized impact sensors 10 are provided on a bumper 13 on the front part of the front 12 of the vehicle by means of which an acceleration signal can be generated in the longitudinal direction of the vehicle and a speed signal can be generated, when a vehicle impact occurs.

[0021] In the present case, a plurality of decentralized impact sensors 10 which form respectively separate units in terms of their arrangement on the bumper 13 are shown on the front part of the front 12 of the vehicle merely by way of example. A desired number of impact sensors can be provided with a very different distribution, for example, at a distance of approximately 10 cm, either on the front part of the front 12 of the vehicle or on a front part 14 of the rear of the vehicle.

[0022] As shown in more detail in Figure 2 and Figure 3, the impact sensors 10 each include first contact sensor elements 15, which face the front 12 of the vehicle, and second contact sensor elements 16, which face away from the front 12 of the vehicle. First and second contact sensor elements 15 and 16, which are spaced apart from one another essentially in the longitudinal direction of the vehicle, generate an acceleration signal or speed signal when a vehicle impact occurs.

[0023] The impact sensors 10, which are embodied here as relative speed sensors, determine a deformation acceleration when an impact of the motor vehicle 1 occurs in the longitudinal direction of the vehicle. The impact sensors 10 may also have a signal processing means which amplifies and digitizes the acceleration signals. Numerical integration of the acceleration signal, which can be carried out by a processor of the control device 3, provides the deformation speed of the frontmost structural region of the motor vehicle 1. From this speed information it is possible to infer the severity of the accident if, for example,

classes for the severity of an accident are assigned in each case to a defined threshold for the acceleration signal and the speed signal.

[0024] If the acceleration signal or the speed signal exceeds such a predefined threshold, a triggering signal which is appropriate for the accident situation is output according to a triggering algorithm stored in the control device 3 to activate safety devices 17. The safety devices 17 can comprise vehicle-occupant restraint devices 18 such as, for example, airbags, seatbelts with seatbelt pretensioners, displaceable impact bodies, cushions and headrests, whose size, hardness, shape and position can be changed by an actuating process, an electric seat adjustment means, a headrest adjustment means or the like, or else pedestrian protection devices, such as an engine hood raising device or an external airbag.

[0025] The selection of the activated safety devices is tailored to the thresholds which are exceeded by an acceleration signal or a speed signal of the impact sensors 10 and the central sensor device 9. A threshold of the central sensor device 9 may be lowered if a high relative speed or collision speed is determined by the impact sensors 10. On the other hand, a low speed accident, designated also a "soft crash", in which none of the safety devices 17 is triggered, can be detected below a minimum threshold of the relative speed or acceleration.

[0026] Referring to Figure 2 and Figure 3, the design of the impact sensors 10 is illustrated in more detail, it being apparent that the first, external contact sensor elements 15 and second, internal contact sensor elements 16 constitute

units which are respectively separate from one another by a free cavity 18 which forms a measured section.

[0027] In the embodiment according to Figure 2, the cavity 18 which forms the measured section and which the external contact sensor element 15 passes through in the direction of the second contact sensor element 16 in the event of a crash is surrounded by a foam-like shaped element 19.

[0028] The contact sensor element 15 lying on the outside of the impact sensor 10 is secured to an outer skin 10 of the bumper 13 and is essentially in the form of a cylindrical plunger here which is embodied in a tapering fashion in the direction of the second contact sensor element 16 for the sake of better mobility in the event of a crash.

[0029] The contact sensor element 16 which lies on the inside is arranged on the highly stable, front crossmember 11 of the motor vehicle and is embodied here as an essentially circular stop.

[0030] The impact sensors 10 may be embodied as piezo-electric sensors or a force-dependent resistor or FSR sensors, but other suitable types of sensors, such as optical waveguides, can also be applied.

[0031] The impact sensors 10 are used to measure a time difference between a first impulse against the respective contact sensor element 15, lying on the outside, and a second impulse against the respective contact sensor element 16, lying on the inside, to generate the speed signal. In this context, when an impulse is applied, the contact sensor elements 15, 16 output, to the control device 3, a voltage signal or a change in resistance, which correlates with

a contact force which exerts the impulse. The control device outputs an activation signal to safety devices 17 of the motor vehicle 1 as a function of whether the speed signal exceeds a predefined threshold.

[0032] The embodiment shown in Figure 3 differs from the embodiment according to Figure 2 in that the impact sensors 10 are integrated into a hollow strip 21 which is attached to the front side of the bumper 13 or embodied in one piece therewith and which extends at least partially along the width of the vehicle. In this context, the first contact sensor element 15 which is on the front side of the vehicle is arranged on a front wall 22 of the hollow strip 21, and the second contact sensor element 16, lying on the inside, is arranged on the front outer skin 20 of the bumper 13.

[0033] Of course, in this embodiment the measured section 18 can also be formed between the first contact sensor element 15 which starts the measurement and the second contact sensor element 16 which stops the measurement, in the hollowing strip 21 within a foam-like shaped part.

[0034] The foregoing disclosure has been set forth merely to illustrate the invention and is not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the invention should be construed to include everything within the scope of the appended claims and equivalents thereof.